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A COMPREHENSIVE SURGICAL APPROACH TO THE TREATMENT OF DEEP STERNAL WOUND INFECTION AFTER HEART TRANSPLANTATION

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Deep wound infection of the anterior chest wall tissues in patients after transsternal cardiac surgery despite intensive developments in surgical techniques and improvement of antibacterial chemotherapy, remains a genuine concern worldwide [1]. The incidence of this complication in the general population ranges from 0.5 to 4% [2, 3]. Despite developed approaches in the treatment of cardiac surgery patients, the treatment of deep sternal wound infection and surrounding tissues following a heart transplantation still remains a rather serious and pressing challenge. This paper presents a clinical observation of a heart transplant recipient, complicated by deep postoperative wound infection. The strategy of staged surgical treatment of sternal osteomyelitis consisted of surgical wound debridement, local wound debridement with vacuum dressings, and reconstructive surgery at the final stage (sternal reosteosynthesis, plasty of the anterior chest wall wound with displaced skin and fascial flaps).

Keywords: heart transplantation, wound infection, sternum, mediastinitis, immunosuppressive therapy, anterior chest wall wound plasty, reosteosynthesis.

INTRODUCTION

Deep wound suppuration in the anterior chest wall after sternotomy as a complication after heart surgery has remained a pressing problem for many decades, especially in the group of heart recipients for whom immunosuppressive therapy is an integral part of the treatment process [1].

Preoperative risk factors include gender, age, bad habits (smoking, alcohol, and drug addiction), diabetes mellitus, and a history of chronic diseases [5]. Intraoperative risks are caused by the urgency of the surgery, sternotomy errors, wound edge retraction techniques, incorrect sternal osteosynthesis, use of soft tissue reduction method, and repeated surgical access (resternotomy, cardiolysis) [11]. The most important intraoperative risk factors for deep wound infection are the volume of blood loss, cardiopulmonary bypass duration, compression (ischemia) in the surgical wound area, traumatic sternal hemostasis technique, use of wax and an electrocoagulator in the spongy sternum area [6]. Postoperative risk factors include sternal instability, sternal ischemia, sternal suture eruption, resternotomy, prolonged mechanical ventilation, cardiac massage, low cardiac output, respiratory distress syndrome, immunosuppression, and decompensation of chronic diseases [12].

The pathogenesis of this complication encompasses a wide range of pathological processes, as well as many perioperative risk factors. Wound infection is characterized by translocation and contamination by pathological microorganisms of wound edges and walls, including the dermis and subcutaneous adipose tissue, with the development of local inflammation, as well as purulent discharge. Deep postoperative wound infection is a serious complication involving various areas of the subcutaneous adipose tissue, fascia, sternum, ribs, and soft tissues of the retrosternal space [2].

The pathological flora found in the wound discharge cultures is mainly represented by St. aureus, St. epidermidis and gram-negative bacteria [3, 4]. High virulence and resistance of hospital microbial strains to antibacterial chemotherapy pose serious challenges in the selection of etiotropic and pathogenetic therapy, and prolong hospitalization time and treatment cost [7], which creates a "vicious circle" for the patient and the attending physician. Deep wound infection after heart transplantation increases mortality by up to 32% [8, 9].

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Currently, there are various surgical methods for replacing anterior chest wall tissue defect forming after surgical treatment of a purulent-necrotic focus. However, they all come with certain risks. For example, plasty with the greater omental flap is associated with high traumatic effect, the risk of developing necrosis, peritonitis, as well as the development of thoraco-abdominal hernia [11]. Myoplasty with the pectoralis major flaps is associated with high trauma and development of necrosis, and the operation is often followed by severe pain syndrome and impaired motor function [12].

One of the most effective and credible ways to treat postoperative osteomyelitis of the sternum and ribs was the staged surgical treatment strategy developed by V.A. Mitish et al. [13, 14, 15]. The reconstructive stage consists in the use of local tissues to replace the anterior chest wall defect formed after surgical treatment. At the same time, local tissues are mobilized in the form of skin-fascial or skin-muscle formations, which are subsequently displaced into the defect. This strategy was the basis for successful treatment in patients after heart transplantation complicated by deep wound infection that required surgical treatment.

CASE STUDY

Patient Y., 59 years old, with complaints of shortness of breath with little physical exertion, swelling of the legs and abdomen, general weakness, right thoracic pain, was hospitalized in November 2019 at Shumakov National Medical Research Center of Transplantology and Artificial Organs in Moscow for examination to ascertain possibility of being a potential heart recipient. Medical history shows that the patient had repeated paroxysmal atrial fibrillation in 2002, 2003 and 2006. In December 2018, examination against the background of complaints of acute chest pain revealed extensive transmural myocardial infarction. As a result, thrombolysis was performed. In July 2019, his EchoCG showed a severe left ventricular aneurysm, and severe pulmonary hypertension. At the same time, coronary angiography was performed: the anterior interventricular branch of the left coronary artery was occluded in the proximal segment, the distal bed was contrasted retrogradely from the circumflex artery.

Upon admission to the cardiology department in October 2019, the patient's condition was assessed as moderate. There were manifestations of chronic heart failure (NYHA class III); right-sided hydrothorax, ascites, hypostatic pneumonia, and chronic kidney disease were noted. According to echocardiographic studies, the ejection fraction was 15%, and the final diastolic volume was 205 mL. Because it was impossible to perform reconstructive surgical treatment on the patient's heart and conservative therapy would be futile, it was decided to perform heart transplantation as the only possible treatment method. The patient was put on the heart transplant waiting list on November 18, 2019.

Against the background of antibacterial, massive diuretic, inotropic therapy, and puncture of the pleural cavities, the patient's condition improved. The severity of shortness of breath decreased, edema and ascites regressed, and the volume of fluid in the pleural cavities decreased. Chest CT showed gradual resolution of pneumonia.

On December 02, 2019, the patient underwent orthotopic heart transplantation. The early postoperative period proceeded against the background of myocardial insufficiency (requiring inotropic support) and renal failure, for which renal replacement therapy sessions were performed.

In the cardiac surgery department after transfer from the intensive care unit, the patient's condition remained hemodynamically stable. Examinations showed a satisfactory graft function. Coronary angiography revealed no hemodynamically significant lesions of the graft coronary arteries. Endomyocardial biopsy revealed no acute cellular and antibody-mediated rejection. There was no fever throughout the postoperative period. However, the patient still had renal insufficiency, which required repeated renal replacement therapy sessions, as well as a tendency to fluid accumulation in the pericardial cavity with signs of right heart compression. As a result, open drainage of the pericardial cavity from subxiphoidal access was performed on December 16, 2019.

On December 22, 2019, the patient was diagnosed with 5 cm of skin and soft tissue diastasis in the middle third of the postoperative suture. Immediate reduction of immunosuppressive therapy was performed - Mycophenolate mofetil was canceled and the antibiotic therapy was adjusted. Within seven days, no positive dynamics was observed. The wound increased in size both in width and length, and purulent discharge appeared. Computed tomography revealed sternum diastasis with osteomalacia at the body level, the xiphoid process and spread of the wound channel into the retrosternal tissue. Postoperative wound suppuration with sternal lesions was diagnosed. Therefore, there was a decision to surgically treat the purulent wound of the anterior chest.

In the operating room on December 30, 2019, the patient underwent wound revision. The wound cavity contained a cloudy purulent discharge, which also came from the retrosternal space. Sternal suture failure and signs of marginal necrosis and destruction of the sternal halves were diagnosed (Fig. 1). The sutures seams were removed. When the sternal halves were diluted, purulent mediastinitis was diagnosed (Fig. 2). Marginal resection of the affected areas of the body and the sternum handle was performed. The altered soft tissue areas were excised. The wound was treated with hydrogen peroxide solution and iodopyron. The operation was completed

by applying a vacuum dressing with pulsating vacuum aspiration (Fig. 3).

In the postoperative period, a culture of Pantoea agglomerans, Acinetobacter baumanni, sensitive to polycyclic antibiotics, such as Polymxin B and Colistin, were taken from the wound. Also, Staphylococcus epidermitis, sensitive only to Linezolid, Vancomycin and Moxifloxacin, was repeatedly found in the cultures from the wound discharge. Antibiotic therapy was adjusted in accordance with the obtained sensitivity of the isolated microorganisms during the entire period of local wound treatment.

Local treatment with NPWT (Negative pressure wound treatment) systems was carried out for 6 weeks.

Scheduled replacement of the vacuum aspiration system was performed in the operating room, during which we performed stage surgical treatment of soft tissue and sternum wounds, sanitation with an antiseptic solution for 10 minutes. Despite the ongoing treatment, the

Fig. 1. View of the postoperative anterior chest wall wound before surgical treatment

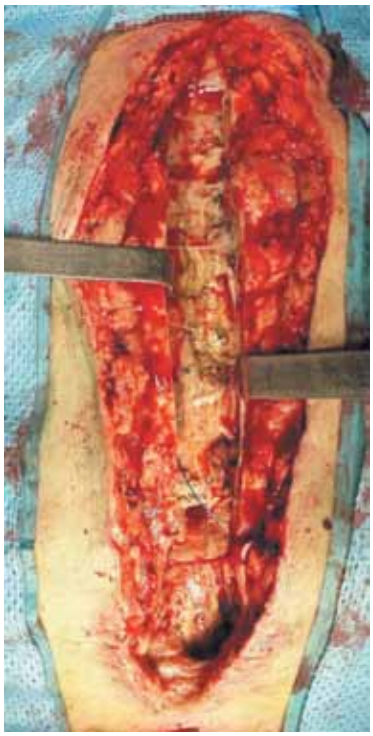

Fig. 2. View of the wound after removal of wire sutures and separation of sternal halves

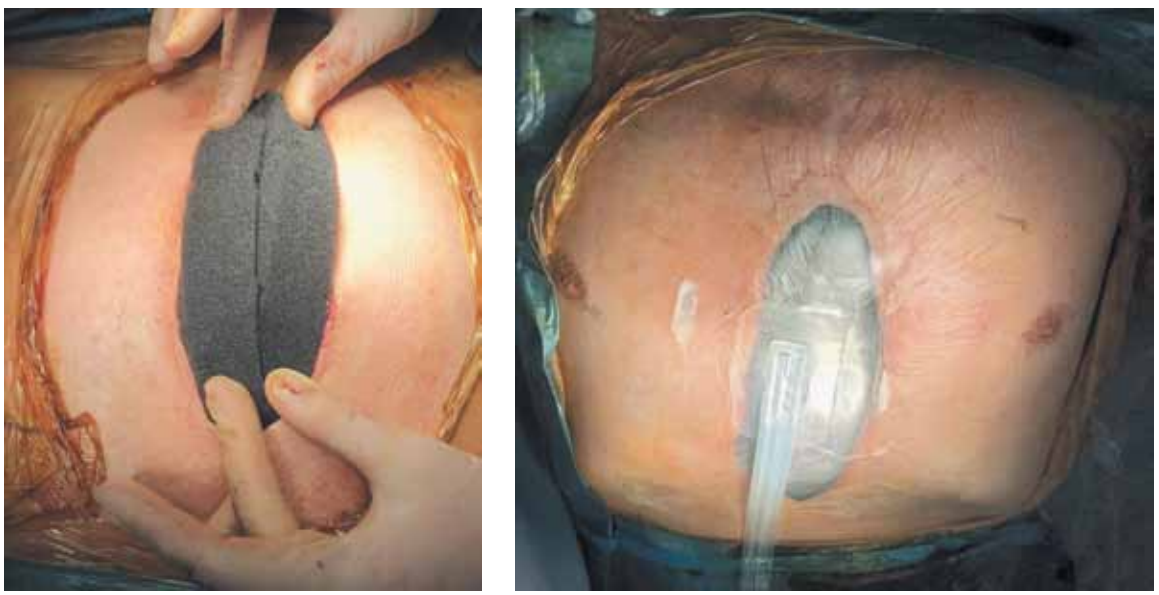

Fig. 3. Completion of surgical wound debridement by imposing a negative pressure wound therapy system

healing process of the postoperative wound had sluggish positive dynamics, the wound walls and bottom were partially filled with edematous granulation tissue, the foci of secondary necrosis appeared in some places (Fig. 4). The patient continued to remain asthenic, have anemia of mixed genesis, chronic kidney disease requiring renal replacement therapy. In the postoperative period, right-sided polysegmental pneumonia joined, which required short-term follow-up in the intensive care unit. All this significantly complicated the course of the wound process and prolonged the hospitalization period.

Fig. 4. Wound condition on day 45 after local treatment with NPWT

By the end of the second month after surgical treatment of the wound, the patient's general condition improved, and positive dynamics of the wound process and its transition to a regeneration phase were noted. The condition of the sternum is shown in Fig. 5.

After three times obtaining sterile cultures from the wound, it was decided to perform the second (reconstructive) stage of surgical treatment - sternal reosteosynthesis and replacement of the soft tissue wound defect in the anterior chest wall with displaced fasciocutaneous flap.

On March 30, 2020, under endotracheal anesthesia, the edges of the soft tissue and sternum wound were acutely treated in the operating room, and granulation areas were removed (Fig. 6). Both sternal halves were mobilized with opening of the pleural cavities (Fig. 7). The anterior mediastinum and pleural cavities were drained with silicone tubes. The sternum edges were brought together and juxtaposed. Sternal rheosteosynthesis was performed according to Robiscek, as well as 8 single oblique-transverse wire sutures (Fig. 8). Satisfactory frame function of the thorax was restored (Fig. 9). The size of the wound defect in the anterior chest wall soft tissue was 17 cm by 5 cm. Closing the wound by simply bringing the edges of the wound together was not possible. Therefore, it was decided to replace the wound defect with local tissues through extensive mobilization of the wound edges in the form of fasciocutaneous flaps.

In a blunt and sharp way, the integumentary tissues were separated from the sternum, the pectoralis major muscles and from the ribs in the lower part of the wound to a 10–12 cm width (Fig. 10).

Fig. 5. Sternal diastasis at the manubrium level and with a bone defect at the body level. 3D reconstruction of CT scan

Fig. 6. Reconstructive surgery phase. Wound edges were excised. Granulation areas were removed, sternal edges were freshened

Using deep U-shaped sutures (in two rows on both sides), the mobilized wound edges were displaced toward the wound defect until they were completely juxtaposed (Fig. 11).

Thanks to the U-shaped tension and stay sutures, the wound edges matched without tension (Fig. 12). The subcutaneous adipose tissue was sutured with single absorbable nodular sutures. The wound edges were sutured with U-shaped skin sutures.

The postoperative period was uneventful. Ischemia, signs of inflammation and significant edema of the displaced integumentary tissues were not observed. The wound healed by primary intention. Antibacterial therapy with Moxifloxacin 400 mg once a day was carried out. According to multispiral chest CT scan on April 20, 2020, slight eruption of the first wire suture in the sternum handle area and 7 mm sternum handle diastasis were noted, which, however, did not affect sternal stability (Fig. 9). On day 14 after reconstructive surgery, the outer rows of U-shaped tension sutures on both sides were removed. After a significant decrease in the discharge along the drains on day 5, drains were removed from

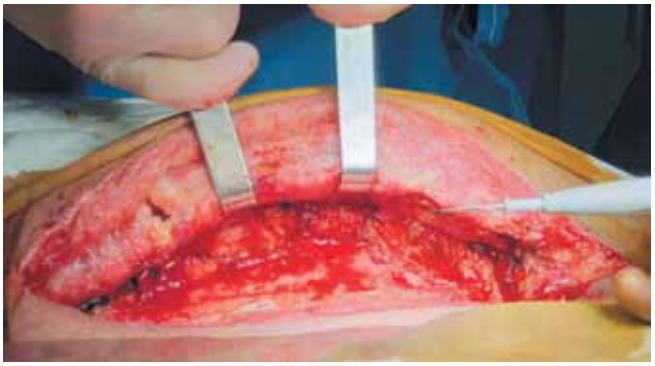

Fig. 7. The retrosternal space of both parts of the sternum was separated from adhesions by blunt and by sharp dissection

Fig. 8. Sternal reosteosynthesis with eight single transverse and one single longitudinal Robicsek wire sutures

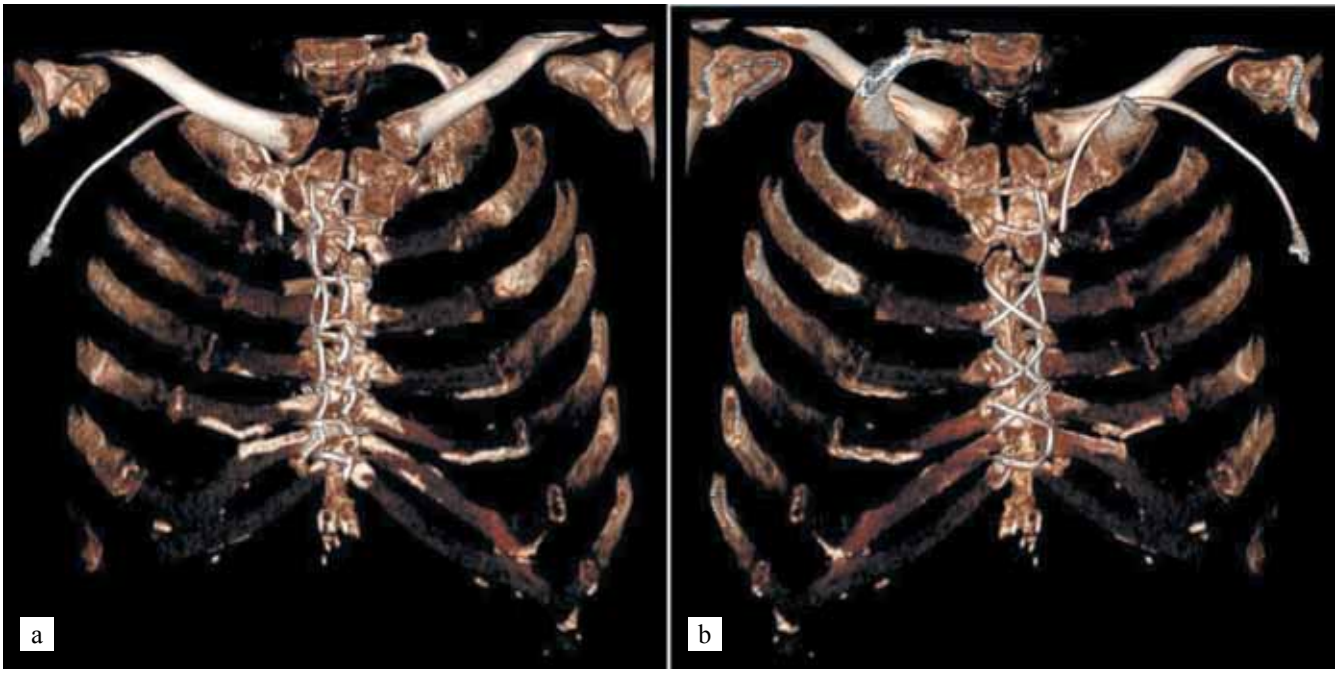

Fig. 9. Sternal reosteosynthesis by Robicsek technique: a) along the front and b) along the inner surfaces of the sternum. 3D reconstruction of CT scan

Fig. 10. Mobilization of wound edge as a fasciocutaneous flap using electrocoagulation

the anterior mediastinum and pleural cavities, and on day 18 after surgery, the inner rows of tension sutures and skin sutures were removed (Fig. 13).

The patient was discharged on day 115 of hospitalization in a satisfactory condition, with no complaints, and with the wound completely healed under outpatient observation by a cardiologist and a surgeon.

CONCLUSION

Surgical complications in the form of deep wound infection after median sternotomy can lead to major consequences for patients, including death. The risks of adverse outcomes are particularly high in patients with a high degree of cardiac cachexia, which are mostly recipients awaiting heart transplantation. In the first months after transplantation, immunosuppressive therapy is the most aggressive, which greatly reduces the body's immune response and reparative capacity. In such a situation, the success of treatment of severe infected wounds threatening the development of generalized infection largely depends on the experience and capabilities of a large team of different specialists. The use of standard methods of treating deep sternal wound infection used in thoracic practice cannot be a universal method for this cohort of patients.

Fig. 11. Displacement of the mobilized full-thickness integumentary tissues of the anterior chest wall into the wound defect using deep U-shaped (flat-topped) sutures

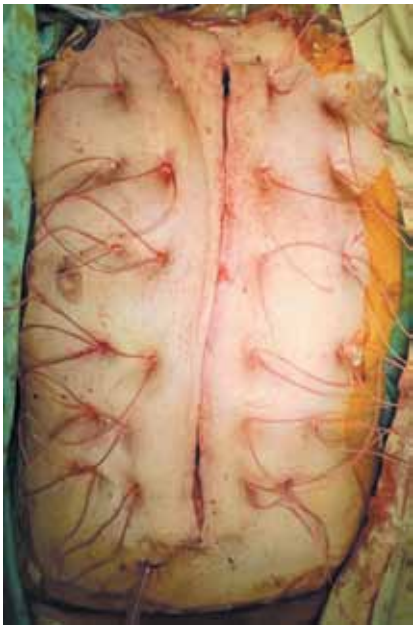

Fig. 12. Replacement of wound defect with local tissues

Fig. 13. View of the anterior chest wall on day 18 after reconstructive surgery. Wound healing by primary intention

The combined approach to surgical treatment of deep sternal wound infection in a heart recipient developed by us, combining such methods as surgical treatment of a purulent-necrotic focus, use of vacuum aspiration with scheduled dressings and replacements of the vacuum aspiration system, transition to "open" management of postoperative wound without vacuum aspiration, with daily dressings, selection of antibiotic therapy based on the obtained cultures, transition to single-component immunosuppression and reduction of serum tacrolimus levels to minimal therapeutic values, staged approach to surgical treatment (serial debridement of the postoperative wound and use of a vacuum aspiration system in the first stage and with subsequent osteosynthesis and soft tissue plasty of the anterior chest wall with displaced fasciocutaneous flaps), allows to successfully handle deep sternal wound infection in heart recipients under immunosuppression.

The authors declare no conflict of interest.

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